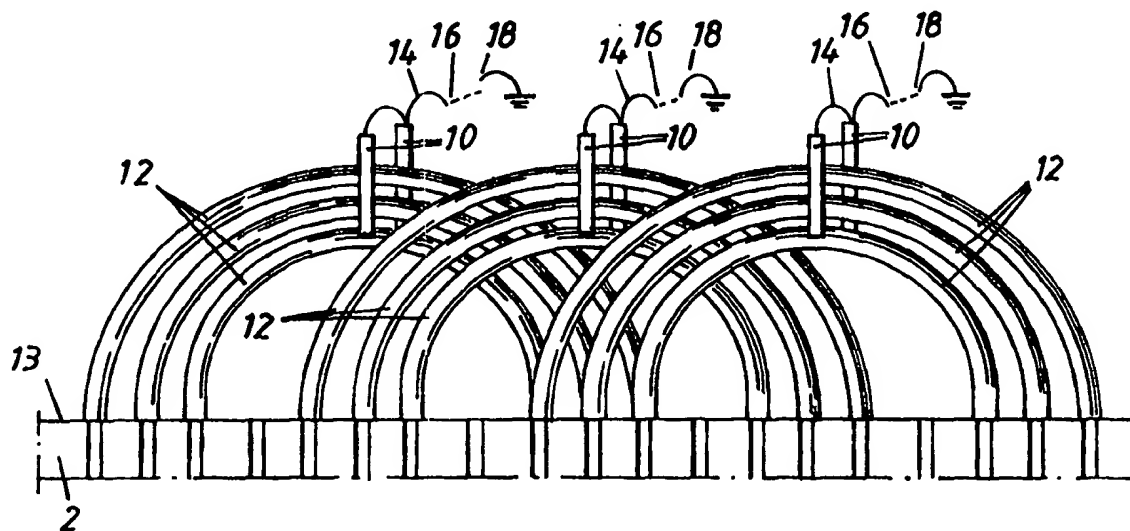




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup>:</b> <b>H02K 3/50</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 98/20598</b> <b>(43) International Publication Date:</b> 14 May 1998 (14.05.98)
<b>(21) International Application Number:</b> PCT/SE97/01844 <b>(22) International Filing Date:</b> 4 November 1997 (04.11.97) <b>(30) Priority Data:</b> 9604034-0      4 November 1996 (04.11.96)      SE <b>(71) Applicant (for all designated States except US):</b> ASEA BROWN BOVERI AB [SE/SE]; S-721 83 Västerås (SE). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> NYGREN, Jan-Anders [SE/SE]; Karlfeldtsgatan 27 B, S-722 22 Västerås (SE). GERTMAR, Lars [SE/SE]; Humlegatan 6, S-722 26 Västerås (SE). TEMPLIN, Peter [SE/SE]; Dybecksgatan 4 B, S-731 40 Köping (SE). <b>(74) Agent:</b> HOPFGARTEN, Nils; L.A. Groth & Co. KB, P.O. Box 6107, S-102 32 Stockholm (SE).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, ES, FI, FI (Utility model), GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the</i> <i>claims and to be republished in the event of the receipt of</i> <i>amendments.</i>

(54) Title: DEVICE FOR CONTROLLING FAULT CURRENTS IN A ROTATING ELECTRIC MACHINE



## (57) Abstract

A device for internal fault current control in the end winding region of the stator (2) in a rotating high-voltage electric machine is inserted in the end winding region. The device consists of conducting material connected to ground. Arcs occurring at breakdown of the winding insulation are deflected to ground via this device.

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 97/01844

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
<b>IPC6: H02K 3/50</b> According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
<b>IPC6: H02K</b>		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
<b>SE,DK,FI,NO classes as above</b>		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>WPI</b>		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 4022476 A1 (THYSSEN INDUSTRIE AG), 16 January 1992 (16.01.92), column 3, line 15 - line 22, figure 2  --	1-2,9-12
Y	DE 584639 C (ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT IN BERLIN), 7 Sept 1933 (07.09.33), figure 1, claim 4  --	1-2,9-12
Y	DE 2050674 A (ALLMAENNA SVENSKA ELEKTRISKA AB), 19 May 1971 (19.05.71), figure 1, claim 1  --	1-2,9-12
Y	US 1418856 A (R.B. WILLIAMSON), 6 June 1922 (06.06.22), page 2, line 35 - line 48, figure 2  --	1-2,9-12
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
7 March 1998		10/03/1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer  Anna Theander Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 97/01844

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5036165 A (RICHARD K. ELTON ET AL.), 30 July 1991 (30.07.91)  -- -----	1-2,9-12

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

03/02/98

International application No.

PCT/SE 97/01844

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
DE	4022476	A1	16/01/92	NONE	
DE	584639	C	07/09/33	NONE	
DE	2050674	A	19/05/71	CH 516249 A GB 1319257 A SE 326758 B US 3670192 A	30/11/71 06/06/73 03/08/70 13/06/72
US	1418856	A	06/06/22	NONE	
US	5036165	A	30/07/91	US 5066881 A US 5067046 A CA 1245270 A US 4853565 A	19/11/91 19/11/91 22/11/88 01/08/89

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

19  
REC'D 08 MAR 1999

WIPO PCT

Applicant's or agent's file reference P 97-402 NH/uh	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SE97/01844	International filing date (day/month/year) 04.11.1997	Priority date (day/month/year) 04.11.1996
International Patent Classification (IPC) or national classification and IPC <sub>6</sub> H 02 K 3/50		
Applicant Asea Brown Boveri AB et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand  29.05.1998	Date of completion of this report  25.02.1999
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer  Karin Säfsten Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE97/01844

## I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☐ the international application as originally filed.

☒ the description, pages 1-6, as originally filed,

pages \_\_\_\_\_, filed with the demand,

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_,

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_.

☐ the claims, Nos. \_\_\_\_\_, as originally filed,

Nos. \_\_\_\_\_, as amended under Article 19,

Nos. \_\_\_\_\_, filed with the demand,

Nos. 1-12, filed with the letter of 19.02.1999,

Nos. \_\_\_\_\_, filed with the letter of \_\_\_\_\_.

☒ the drawings, sheets/fig 1-9, as originally filed,

sheets/fig \_\_\_\_\_, filed with the demand

sheets/fig \_\_\_\_\_, filed with the letter of \_\_\_\_\_,

sheets/fig \_\_\_\_\_, filed with the letter of \_\_\_\_\_.

2. The amendments have resulted in the cancellation of:

☐ the description, pages \_\_\_\_\_

☐ the claims, Nos. \_\_\_\_\_

☐ the drawings, sheets/fig \_\_\_\_\_

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE97/01844

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims	<u>1-12</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-12</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-12</u>	YES
	Claims		NO

**2. Citations and explanations**

The present invention relates to a device for controlling fault currents in the end winding region of the stator in a rotating high-voltage electric machine.

The invented solution consists of a device comprising a rod or a pipe of an electrically conducting material connected to ground and arranged in the end winding region.

New, amended claims have been filed with the letter of 19 February 1999.

The following documents are included in the International Search Report:

D1: DE 4022476 A1 (THYSSEN INDUSTRIE AG), 16 January 1992

D2: DE 584639 C (ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT IN BERLIN), 7 September 1933

D3: DE 2050674 A (ALLMAENNA SVENSKA ELEKTRISKA AB), 19 May 1971

D4: US 1418856 A (R.B. WILLIAMSON), 6 June 1922

D5: US 5036165 A (RICHARD K. ELTON ET AL.), 30 July 1991

.../...



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE97/01844

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V.

However, the most relevant prior art consists of D1, showing a high voltage cable for a linear electric machine, with a device for fault current control comprising wires of an electrically conductive material (copper), connected to ground, and arranged in the end of the winding region. (See column 3, line 11-column 4, line 33). The cable comprises a current carrying conductor(8), around which a first conducting layer(9) is arranged, a second insulating layer(10) and an outer conducting layer(11).

The subject matter claimed differs from what is known from D1 only in the sense that it relates to a rotating electric machine instead of a linear electric machine. It is, however, not obvious for a person skilled in the art to look into the area of linear motors when designing a rotating machine, because of the differences in the construction of linear machines and rotating machines, which e.g. results in differences in cooling demand.

Therefore, the invention according to the amended claims 1-12 is considered to be novel(N), to involve an inventive step(IS) and to comprise industrial applicability(IA).

## AMENDED CLAIMS

1. A rotating electric machine for high voltage comprising a stator (2), a rotor and windings, characterized in that the windings comprise high voltage cables enclosing the electric field within the windings and in that a device (10) for fault current control is provided comprising a rod, pipe or the like of an electrically conducting material connected to ground and arranged in the end winding region.
2. A rotating electrical machine as claimed in claim 1, characterized in that an arrangement of rods, pipes or the like in the end winding region is placed so that the largest physical distance between the rods, pipes or the like is small enough to ensure a deflection of an arc in the end winding region to ground.
3. A rotating electrical machine as claimed in claim 1 or claim 2, characterized in that the rods, pipes or the like are inserted a specific distance into the end winding region and this distance being limited, so that eddy currents produced in the rods, pipes or the like are below a predetermined magnitude.
4. A rotating electrical machine as claimed in any of claims 1-3, characterized in that the rods, pipes or the like are slotted in order to reduce eddy-current losses.
5. A rotating electrical machine as claimed in any of claims 1-3, characterized in that the rods, pipes or the like comprises a plurality of small conductors combined in to a bundle having sufficient cross-sectional area to deflect short-circuit currents arising in the end winding region in the event of a fault.
6. A rotating electrical machine as claimed in any of claims 1-5, characterized in that the rods, pipes or the like are arranged to be in contact with spacers of resilient, electrically conducting material, said spacers being applied between adjacent cables in the end winding region and in contact with the outer semi-conducting layers of the cables.
7. A rotating electrical machine as claimed in claim 6, characterized in that the rods, pipes or the like are inserted into the spacers.
8. A rotating electrical machine as claimed in any of claims 6-7, characterized in that the rods, pipes or the like are arranged in contact with several spacers arranged one after the other in the direction of the end of the stator.

9. A rotating electrical machine as claimed in any of claims 1-8, characterized in that the device consist of a flexible wire.

5 10. A rotating electrical machine as claimed in any of claims 1-9, characterized in that the device also is used to mechanically stabilize the end winding.

11. A rotating electric machine as claimed in any of the claims 1-10,  
10 characterized in that the high voltage cable is flexible and comprises one or more current-carrying conductor, wherein around each conductor there is arranged an inner layer with semiconducting properties and around the inner layer there is arranged a solid insulating part and around the insulating part there is arranged an outer layer with semiconducting properties.

15 12. A rotating electric machine as claimed in any of the claims 1-11, characterized in that the winding thereof is designed for a voltage suitably in excess of 36 kV, and preferably up to very high voltages, such as 400 kV to 800 kV.

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## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

HOPFGARTEN, Nils  
L.A. Groth & Co. KB  
P.O. Box 6107  
S-102 32 Stockholm  
SUÈDE

<b>Date of mailing (day/month/year)</b> 23 November 1998 (23.11.98)	<b>IMPORTANT NOTIFICATION</b>
<b>Applicant's or agent's file reference</b> P 97-402/NH	
<b>International application No.</b> PCT/SE97/01844	<b>International filing date (day/month/year)</b> 04 November 1997 (04.11.97)

1. The following indications appeared on record concerning:		
<input checked="" type="checkbox"/> the applicant	<input checked="" type="checkbox"/> the inventor	<input type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address TEMPLIN, Peter Björnjaktsvägen 20 S-722 42 Västerås Sweden	State of Nationality SE	State of Residence SE
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input type="checkbox"/> the person	<input type="checkbox"/> the name	<input checked="" type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence
Name and Address TEMPLIN, Peter Kumleskärsgatan 59 S-421 58 Västra Frölunda Sweden	State of Nationality SE	State of Residence SE
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary:		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned	
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	

<b>The International Bureau of WIPO</b> 34, chemin des Colombettes 1211 Geneva 20, Switzerland	<b>Authorized officer</b> B. Fitzgerald
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark  
Office  
(Box PCT)  
Crystal Plaza 2  
Washington, DC 20231  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

<b>Date of mailing</b> (day/month/year) 19 June 1998 (19.06.98)	<b>Applicant's or agent's file reference</b> P 97-402/NH  <b>Priority date</b> (day/month/year) 04 November 1996 (04.11.96)
<b>International application No.</b> PCT/SE97/01844	
<b>International filing date</b> (day/month/year) 04 November 1997 (04.11.97)	
<b>Applicant</b> NYGREN, Jan-Anders et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
29 May 1998 (29.05.98)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was  
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No.: (41-22) 740.14.35	Authorized officer  M. Abidine  Telephone No.: (41-22) 338.83.38
---	--

**PCT**

**NOTIFICATION OF THE RECORDING  
 OF A CHANGE**

(PCT Rule 92bis.1 and  
 Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

HOPFGARTEN, Nils  
 L.A. Groth & Co. KB  
 P.O. Box 6107  
 S-102 32 Stockholm  
 SUEDE

Date of mailing (day/month/year) 28 May 1998 (28.05.98)	<b>IMPORTANT NOTIFICATION</b>
Applicant's or agent's file reference P 97-402/NH	
International application No. PCT/SE97/01844	International filing date (day/month/year) 04 November 1997 (04.11.97)

1. The following indications appeared on record concerning:

☒ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address

TEMPLIN, Peter  
 Dybecksgatan 4 B  
 S-731 40 Köping  
 Sweden

State of Nationality

SE

State of Residence

SE

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address

TEMPLIN, Peter  
 Björnjaktsvägen 20  
 S-722 42 Västerås  
 Sweden

State of Nationality

SE

State of Residence

SE

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office ☒ the designated Offices concerned  
☐ the International Searching Authority ☐ the elected Offices concerned  
☐ the International Preliminary Examining Authority ☐ other:

The International Bureau of WIPO  
 34, chemin des Colombettes  
 1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Nicola Wolff

Telephone No.: (41-22) 338.83.38

## PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P 97-402 NH/uh	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SE97/01844	International filing date (day/month/year) 04.11.1997	Priority date (day/month/year) 04.11.1996
International Patent Classification (IPC) or national classification and IPC <sub>6</sub> H 02 K 3/50		
Applicant Asea Brown Boveri AB et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 29.05.1998	Date of completion of this report 25.02.1999
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Karin Säfsten Telephone No. 08-782 25 00

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE97/01844

## I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

- ☐ the international application as originally filed.
- ☒ the description, pages 1-6, as originally filed,  
pages \_\_\_\_\_, filed with the demand,  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_,  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_.
- ☐ the claims, Nos. \_\_\_\_\_, as originally filed,  
Nos. \_\_\_\_\_, as amended under Article 19,  
Nos. \_\_\_\_\_, filed with the demand,  
Nos. 1-12, filed with the letter of 19.02.1999,  
Nos. \_\_\_\_\_, filed with the letter of \_\_\_\_\_.
- ☒ the drawings, sheets/fig 1-9, as originally filed,  
sheets/fig \_\_\_\_\_, filed with the demand  
sheets/fig \_\_\_\_\_, filed with the letter of \_\_\_\_\_,  
sheets/fig \_\_\_\_\_, filed with the letter of \_\_\_\_\_.

## 2. The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheets/fig \_\_\_\_\_

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

## 4. Additional observations, if necessary:



## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE97/01844

**V. Resoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims	<u>1-12</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-12</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-12</u>	YES
	Claims		NO

**2. Citations and explanations**

The present invention relates to a device for controlling fault currents in the end winding region of the stator in a rotating high-voltage electric machine.

The invented solution consists of a device comprising a rod or a pipe of an electrically conducting material connected to ground and arranged in the end winding region.

New, amended claims have been filed with the letter of 19 February 1999.

The following documents are included in the International Search Report:

D1: -DE 4022476 A1 (THYSSEN INDUSTRIE AG), 16 January 1992

D2: DE 584639 C (ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT IN BERLIN), 7 September 1933

D3: DE 2050674 A (ALLMAENNA SVENSKA ELEKTRISKA AB), 19 May 1971

D4: US 1418856 A (R.B. WILLIAMSON), 6 June 1922

D5: US 5036165 A (RICHARD K. ELTON ET AL.), 30 July 1991

.../...

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE97/01844

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V.

However, the most relevant prior art consists of D1, showing a high voltage cable for a linear electric machine, with a device for fault current control comprising wires of an electrically conductive material (copper), connected to ground, and arranged in the end of the winding region. (See column 3, line 11-column 4, line 33). The cable comprises a current carrying conductor(8), around which a first conducting layer(9) is arranged, a second insulating layer(10) and an outer conducting layer(11).

The subject matter claimed differs from what is known from D1 only in the sense that it relates to a rotating electric machine instead of a linear electric machine. It is, however, not obvious for a person skilled in the art to look into the area of linear motors when designing a rotating machine, because of the differences in the construction of linear machines and rotating machines, which e.g. results in differences in cooling demand.

Therefore, the invention according to the amended claims 1-12 is considered to be novel(N), to involve an inventive step(IS) and to comprise industrial applicability(IA).

## AMENDED CLAIMS

1. A rotating electric machine for high voltage comprising a stator (2), a rotor and windings, characterized in that the windings comprise high voltage cables enclosing the electric field within the windings and in that a device (10) for fault current control is provided comprising a rod, pipe or the like of an electrically conducting material connected to ground and arranged in the end winding region.
2. A rotating electrical machine as claimed in claim 1, characterized in that an arrangement of rods, pipes or the like in the end winding region is placed so that the largest physical distance between the rods, pipes or the like is small enough to ensure a deflection of an arc in the end winding region to ground.
3. A rotating electrical machine as claimed in claim 1 or claim 2, characterized in that the rods, pipes or the like are inserted a specific distance into the end winding region and this distance being limited, so that eddy currents produced in the rods, pipes or the like are below a predetermined magnitude.
4. A rotating electrical machine as claimed in any of claims 1-3, characterized in that the rods, pipes or the like are slotted in order to reduce eddy-current losses.
5. A rotating electrical machine as claimed in any of claims 1-3, characterized in that the rods, pipes or the like comprises a plurality of small conductors combined in to a bundle having sufficient cross-sectional area to deflect short-circuit currents arising in the end winding region in the event of a fault.
6. A rotating electrical machine as claimed in any of claims 1-5, characterized in that the rods, pipes or the like are arranged to be in contact with spacers of resilient, electrically conducting material, said spacers being applied between adjacent cables in the end winding region and in contact with the outer semi-conducting layers of the cables.
7. A rotating electrical machine as claimed in claim 6, characterized in that the rods, pipes or the like are inserted into the spacers.
8. A rotating electrical machine as claimed in any of claims 6-7, characterized in that the rods, pipes or the like are arranged in contact with several spacers arranged one after the other in the direction of the end of the stator.

9. A rotating electrical machine as claimed in any of claims 1-8, characterized in that the device consist of a flexible wire.

5 10. A rotating electrical machine as claimed in any of claims 1-9, characterized in that the device also is used to mechanically stabilize the end winding.

10 11. A rotating electric machine as claimed in any of the claims 1-10, characterized in that the high voltage cable is flexible and comprises one or more current-carrying conductor, wherein around each conductor there is arranged an inner layer with semiconducting properties and around the inner layer there is arranged a solid insulating part and around the insulating part there is arranged an outer layer with semiconducting properties.

15 12. A rotating electric machine as claimed in any of the claims 1-11, characterized in that the winding thereof is designed for a voltage suitably in excess of 36 kV, and preferably up to very high voltages, such as 400 kV to 800 kV.

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INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE 97/01844

**A. CLASSIFICATION OF SUBJECT MATTER**

**IPC6: H02K 3/50**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

**IPC6: H02K**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**WPI**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 4022476 A1 (THYSSEN INDUSTRIE AG), 16 January 1992 (16.01.92), column 3, line 15 - line 22, figure 2 --	1-2,9-12
Y	DE 584639 C (ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT IN BERLIN), 7 Sept 1933 (07.09.33), figure 1, claim 4 --	1-2,9-12
Y	DE 2050674 A (ALLMAENNA SVENSKA ELEKTRISKA AB), 19 May 1971 (19.05.71), figure 1, claim 1 --	1-2,9-12
Y	US 1418856 A (R.B. WILLIAMSON), 6 June 1922 (06.06.22), page 2, line 35 - line 48, figure 2 --	1-2,9-12

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

**7 March 1998**

Date of mailing of the international search report

**10/03/1998**

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 97/01844

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y

US 5036165 A (RICHARD K. ELTON ET AL.),  
30 July 1991 (30.07.91)

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1-2,9-12

## INTERNATIONAL SEARCH REPORT

Information on patent family members

03/02/98

International application No.

PCT/SE 97/01844

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4022476 A1	16/01/92	NONE	
DE 584639 C	07/09/33	NONE	
DE 2050674 A	19/05/71	CH 516249 A GB 1319257 A SE 326758 B US 3670192 A	30/11/71 06/06/73 03/08/70 13/06/72
US 1418856 A	06/06/22	NONE	
US 5036165 A	30/07/91	US 5066881 A US 5067046 A CA 1245270 A US 4853565 A	19/11/91 19/11/91 22/11/88 01/08/89

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE 99/00943

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H02J 3/36

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
D,A	WO 9745908 A1 (SIEMENS AKTIENGESSELLSCHAFT), 4 December 1997 (04.12.97), figure 3, abstract	1-27
A	WO 9843336 A2 (ASEA BROWN BOVERI AB), 1 October 1998 (01.10.98), page 7, line 1 - line 10, figure 1	1-27
A	US 5499178 A (NED MOHAN), 12 March 1996 (12.03.96), column 13, line 5 - line 31, figure 8	1-27

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

- \* Special categories of cited documents
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "B" prior document but published on or after the international filing date
- "C" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another claim or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

16 February 2000

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Date of mailing of the international search report

22-02-2000

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INTERNATIONAL SEARCH REPORT  
Information on patent family members

International application No.  
PCT/SE 99/00943

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		CA 2218942 A	24/09/98
		EP 0909354 A	21/04/99
		SE 9701060 A	04/03/98
		SE 9703329 A	25/09/98
		US 5980095 A	09/11/99
US 5499178 A	12/03/96	WO 9418683 A	18/08/94
		EP 0617858 A	05/10/94
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		WO 9312576 A	24/06/93